CHM129

Empirical and Molecular Formulas

1. Elemental analysis of lactic acid shows that it contains 40.0% C, 6.71% H and 53.3% O. Find the empirical and molecular formulas. The molar mass of lactic acid is 90.08 g/mol.

$$40.0\ g\,C \left(\frac{1\ mol\ C}{12.01\ g\,C}\right) = 3.33\ mol\ C$$

$$6.71\ g\,H \left(\frac{1\ mol\ H}{1.01\ g\,H}\right) = 6.64\ mol\ H \quad \Longrightarrow \quad C_{3.33}H_{6.64}O_{3.33}$$

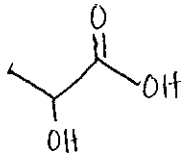
$$53.3\ g\,O \left(\frac{1\ mol\ O}{16.00\ g\,O}\right) = 3.33\ mol\ O$$

$$\frac{C_{3.33}}{3.33}\frac{H_{6.64}}{3.33}\frac{O_{3.33}}{3.33} \Longrightarrow \underline{CH_2O}$$ Empirical Formula

Molar Mass: 30.03 g/mol

$$n = \frac{90.08\ g/mol}{30.03\ g/mol} = 3$$

$$(CH_2O) \times 3 = \underline{C_3H_6O_3}$$ Molecular Formula



2. Vitamin C contains C, H, and O. A 1.000 g sample is burned and the following data are obtained: 1.50g CO_2 and 0.41 g H_2O. Its molar mass is 176.12 g/mol. Find the empirical and molecular formulas.

mass C: $1.50\text{g } CO_2 \left(\frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2}\right)\left(\frac{1\text{ mol C}}{1\text{ mol } CO_2}\right)\left(\frac{12.01\text{ g C}}{1\text{ mol C}}\right) = 0.409\text{ g C}$

mass H: $0.41\text{ g } H_2O \left(\frac{1\text{ mol } H_2O}{18.02\text{ g } H_2O}\right)\left(\frac{2\text{ mol H}}{1\text{ mol } H_2O}\right)\left(\frac{1.01\text{ g H}}{1\text{ mol H}}\right) = 0.046\text{ g H}$

mass O: $1.000\text{ g Vit. C} - 0.409\text{ g C} - 0.046\text{ g H} = 0.545\text{ g O}$

$0.409\text{ g C}\left(\frac{1\text{ mol C}}{12.01\text{ g C}}\right) = 0.0341\text{ mol C}$

$0.046\text{ g H}\left(\frac{1\text{ mol H}}{1.01\text{ g H}}\right) = 0.046\text{ mol H} \Rightarrow C_{0.0341}H_{0.046}O_{0.0341}$

$0.545\text{ g O}\left(\frac{1\text{ mol O}}{16.00\text{ g O}}\right) = 0.0341\text{ mol O}$

$\frac{C_{0.0341}}{0.0341}\frac{H_{0.046}}{0.0341}\frac{O_{0.0341}}{0.0341} \Rightarrow (CH_{1.3}O) \times 3 \Rightarrow C_3H_4O_3$ Empirical Formula

Molar Mass: 88.07 g/mol

$n = \frac{176.12\text{ g/mol}}{88.07\text{ g/mol}} = 2$

$(C_3H_4O_3) \times 2 = C_6H_8O_6$ Molecular Formula